The (Proposed) ASHRAE Standard 189.1 High-Performance, Green Buildings

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Environmental ENGINEERING
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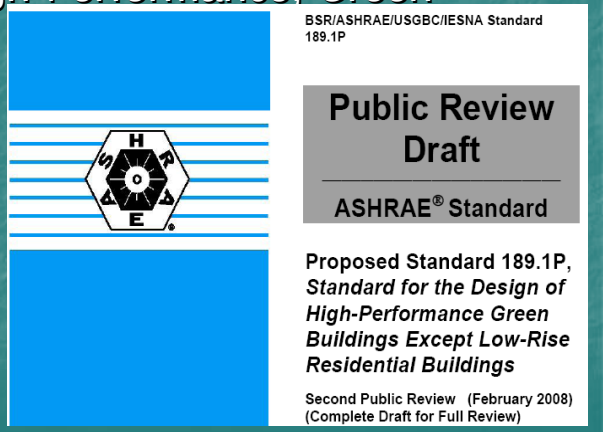
ASHRAE Standard 189.1

- Overview of proposed ASHRAE Standard 189.1 for "High-Performance, Green Buildings"
  - What is it?
  - Why have it?
  - Status
  - Highlights



ASHRAE's More Active Role in Sustainable Design

- Sustainability Policy

Strategic Plan

Strategic Plan Directives

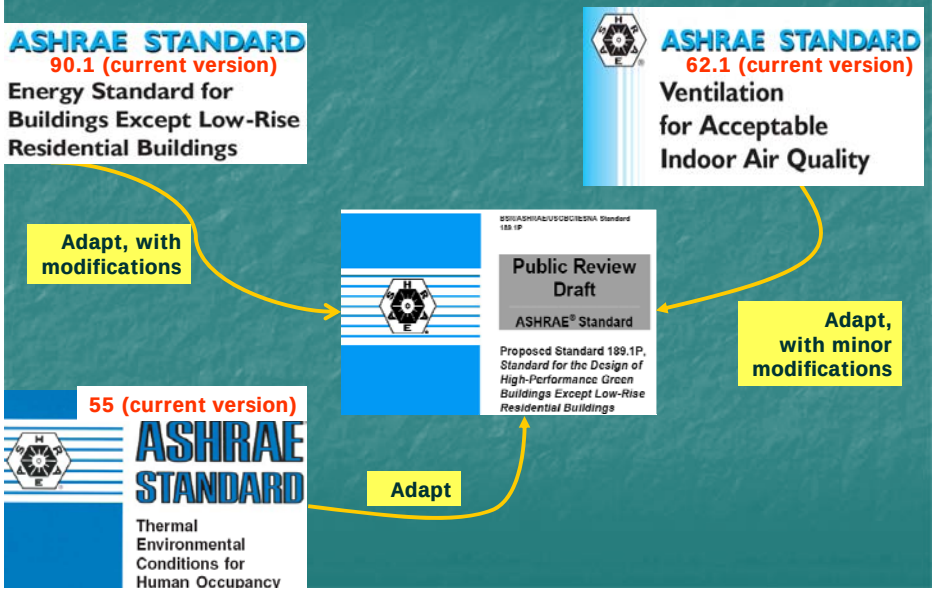
- ASHRAE will lead the advancement of sustainable building design and operations.
- ASHRAE will be a world-class provider of education and certification programs.
- ASHRAE will position itself as premier provider of HVAC&R expertise.
- ASHRAE will be a global leader in the HVAC&R community.

Standard 189.1: Intent

- What Standard 189.1 is:
  - a standard
  - applies to all buildings except low-rise residential buildings (same as ASHRAE Std 90.1)
  - intended for adoption into model building codes
- What Standard 189.1 is not:
  - not a design guide
  - not a rating system

Even if not adopted by local authorities, this Standard is an indication of future trends

Standard 189.1: Relation to Other ASHRAE Standards



Why is this Needed?

- Localities are beginning to adopt "green building" as a requirement
  - LEED certification (to some level)
  - Others are more vague
- Intended to fill a gap in evolving building codes
- ASHRAE partnership with USGBC, IESNA, and will be submitted for ANSI approval

Organization and What it Covers

- Similar to other ASHRAE standards and LEED

ASHRAE/USGBC/IESNA Standard 189.1,
Standard for High-Performance Green Buildings
Except Low-Rise Residential Buildings

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- Mandatory
- Prescriptive
- Performance

Section 2 - Purpose

"The purpose of this standard is to provide minimum requirements for the ***siting, design, construction, and plans for operation*** of high performance, green buildings to:

(a) ***balance*** environmental responsibility, resource efficiency, occupant comfort and well being, and community sensitivity, and

(b) support the goal of development that ***meets the needs of the present without compromising*** the ability of future generations to meet their own needs. "

Section 2 - Scope

- Provides minimum criteria that:

  (a) Apply to **new buildings and major renovation projects** (new portions or new systems).

  (b) Addresses site sustainability, water and energy efficiency, IEQ the building's impact on the atmosphere, materials and resources.

- **Does not apply to:**

  (a) single-family residential, multi-family <3 stories, manufactured houses (mobile or modular homes);

  (b) buildings that do not use electricity, fossil fuel or water.

Progress and Status

- 1st Draft created: June 2006 – April 2007
- 45-Day public review period May-July '07
  - 964 total comments received
- Fall 2007, 189.1 committee modified for 2nd Public Review Draft
- **2nd public review schedule**
  - Feb. 22 – April 7, 2008: 2nd public review
  - Summer 2008 – committee reviews comments drafting Independent Substantive Change
  - Fall 2008 3rd public review, of the ISC items

Goals for Standard 189.1

- **Establish mandatory criteria in all topical areas:**
  - one 'problem' with existing rating systems is that they contain few mandatory provisions
  - avoids claims about a 'green building', but still making **no** improvements in some areas
- **Provide simple compliance options:**
  - another critique of existing rating systems is the need for extensive calculations (e.g. energy)
- **Complement green building rating programs:**
  - Std 189.1 is **not** intended to compete with green building rating programs

Sponsors and Project Committee

- Consensus process
- Sponsor and co-sponsors:
  - ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers)
  - USGBC (U.S. Green Building Council)
  - IESNA (Illuminating Engineering Society of North America
- Project committee:
  22 voting members;
  variety of disciplines,
  industries & organizations

Challenges

- Using normative (code) language
- Determining the stringency for a "minimum" standard
- Identifying standards or regulations to cite *(could not reference guidelines)*
- Prescribing universal strategies *(requirements for all, not a menu)*
- Coordination with other initiatives
- Creating something that is enforceable

Indirect Benefits of Establishing Baseline

- **More certainty for manufacturers**
  - Will develop and provide next generation products if a market is known to exist
- **Benefits to existing buildings**
  - Suppliers will stock better performing products as they become available

Potential Users of Std. 189.1

- Organizations with green building rating systems (LEED, Green Building Initiative)
- **Developers:** individual projects
- **Corporations:** corporate owned
- **Universities:** campus buildings
- **States/provinces/municipalities:**
  - their own buildings
  - basis for incentives
  - private construction, through reference in local codes

Standard 189.1 Basic Structure

For Each Section

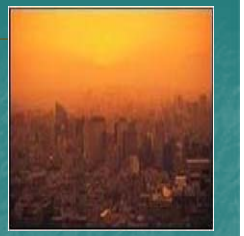
- x.1: Scope
- x.2: Compliance
- x.3: Mandatory (required for all projects)
- x.4: Prescriptive **option** (simple option, minimal choices, very few calculations)
- x.5: Performance **option** (more sophisticated, flexibility, but more effort)

Highlights of Standard 189.1

Chapter 5 - Sites:

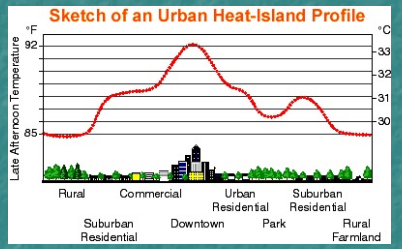
- **Discourages unmitigated sprawl**
- **Prohibited development activity**
  - Flood plains, wetlands, fish and wildlife habitat
- **Other areas that are addressed:**
  - Amount of impervious surface area *[max of 60% of total site to be impervious]*
  - Urban heat island *[shaded or higher solar reflective index materials]*
  - Light "pollution" limitations

Sustainable Sites



Mandatory Provisions

- **Heat island effect**
  - Site hardscape: to be shaded, be SRI 29, or porous pavers
  - Wall: to be shaded up to 20 feet above grade
  - Roofs: to be SRI 78 (low-slope)/29 (steep-slope) or cool roof



Definition: *SRI*

solar reflectance index (SRI): a measure of a constructed surface's ability to reflect solar heat, as shown by a small temperature rise.

'Standard' black = 0; 'standard' white = 1

Confusion of Heat Island with Building Heat Gains

- Two separate issues!
  - Heat Island

heat island effect: the tendency of urban areas to be at a warmer temperature than surrounding rural areas.

  - Building heat gain
    - A "cool roof" is just one of the potential strategies for reducing heat gain to a building structure

The Heat Island effect is a *Site* issue (Section 5); heat gain to a building (and how fast it enters the building) is primarily an *Energy* issue (Section 7)

Sustainable Sites

Mandatory Provisions

- **Reduction of light pollution**
  - Outdoor lighting trespass: limits on horizontal and vertical lux

Sustainable Sites

Prescriptive Path for Compliance

- **Site Development**
  - All sites: Min. 40% of area to be effective pervious surface (vegetation, green roof, porous pavers)
  - Greenfield sites: Min. 20% of area native or adapted plants

Chapter 6 – Water Use Efficiency

Mandatory Provisions

- **Site water use**: bio-diverse plantings, hydrozoning, & smart irrigation controllers

Chapter 6 – Water Use Efficiency

Mandatory Provisions

- **Building water use**: **(§6.3.2.1)** plumbing fixtures & fittings per U.S. EPA WaterSense or ASME Standards **(§6.3.2.2)** appliances per U.S. EPA EnergyStar, with water use factor for public access appliances

Chapter 6 – Water Use Efficiency

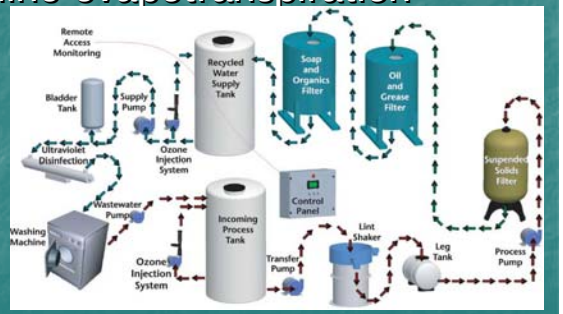
Mandatory Provisions (Cont'd)

- **HVAC Systems (§6.3.2.3)**:
  - Once through cooling prohibited
  - Cooling tower makeup and blowdown meters, efficient drift eliminators
  - Condensate collection from units > 19 kW (65,000 Btu/hr)

Chapter 6 – Water Use Efficiency

Performance Option

- **Site water use reduction**: proposed potable water for irrigation < 35% of baseline evapotranspiration
- **Building use**:



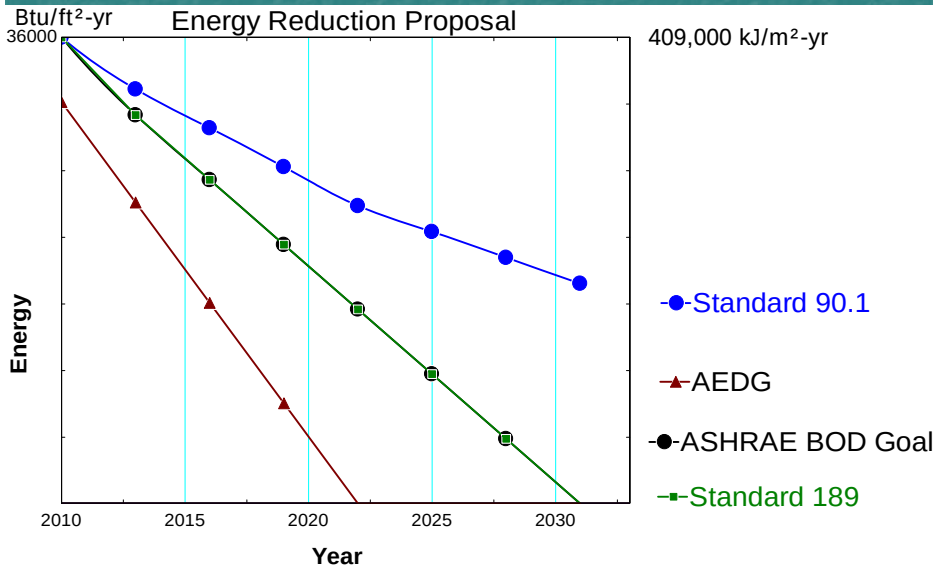
Proposed use < [mandatory+ prescriptive]

Highlights for Energy (Chapter 7)

Energy - General:

- Goal is 30% less than Standard 90.1-2007 ***INCLUDING PROCESS LOADS***
- Appendix G from Standard 90.1 is incorporated as a Normative Appendix
- Metering for verification
- Peak load reduction
- Other areas increase stringency beyond Standard 90.1

ASHRAE Energy Goals



Highlights for Energy (Chapter 7)

- **Mandatory Requirements:**
  - **On-site renewable power (§7.3.2)** 1% of service overcurrent rating
  - **Exceptions**
  - solar hot water heating with 100% total use **or** peak capacity = 2.5% of service overcurrent rating
  - By 10% improvement in energy efficiency plus CO_{2e} reduction

Revised in ISC

80% → 2.0%

the *service overcurrent protection device rating*. The rating of the *on-site renewable energy power system* shall be the nameplate rating in kVA (dc).

Highlights for Energy (Chapter 7)

Energy – Mandatory continued:

- **Remote or automatic reading meters (§7.3.3)** *criteria based on size*
  - Energy sources (Table 7.3.3-1)
  - Key systems (Table 7.3.3-2)
- Meters communicate to central recording system

Highlights for Energy (Chapter 7)

Metering Thresholds:

May be Revised in ISC

Table 7.3.3-1 Energy Source Meter Thresholds

Energy Source	Main Metering Threshold
Electrical service	> 200 kVA
On-site renewable energy power	All systems > 1 kVA (peak)
Gas and steam service	> 300 kW (1,000,000 Btu/h)
Geothermal	> 300 kW (1,000,000 Btu/h) heating
Solar thermal	> 10 kW (30,000 Btu/h)

Table 7.3.3-2 Component Energy Metering Thresholds

Component	Sub-Metering Threshold
Chillers/heat pumps	> 70 kW (240,000 Btu/h) cooling capacity
Packaged AC units	> 70 kW (240,000 Btu/h) cooling
Fans	> 15 kW (20 hp)
Pumps	> 15 kW (20 hp)
Cooling towers	> 15 kW (20 hp)
Boilers and other heating equipment	> 300 kW (1,000,000 Btu/h) input
General lighting circuits	> 100 kVA
Miscellaneous electric loads	> 100 kVA

Highlights for Energy (Chapter 7)

Prescriptive Option (General)

- Target is to comply with Standard 90.1-2007 ***plus…30% savings***
- Standard 189.1 builds from 90.1-2007 …

7.4.1 General Comprehensive Prescriptive Requirements. When a requirement is provided below, it supersedes the requirement in ASHRAE/IESNA Standard 90.1. For all other criteria, the *building project* shall comply with the requirements of ASHRAE/IESNA Standard 90.1.

Highlights for Energy (Chapter 7)

Prescriptive Option (Continued)

- Prescriptive Option:
  - Lower lighting power density (90%), expand occupancy sensor control
  - Increased requirement for economizers and variable speed controls

Climate Zones	Cooling Capacity for Which an Economizer is Required
1A, 1B, 2A	No Economizer Requirement
2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	≥ 9.7 kW (33,000 Btu/h)[a]

  - SHGC , East & West window area combination limits for climate zones 1-4 (west only in 5-6)

Highlights for Energy (Chapter 7)

(§7.4.2 a)

Prescriptive Option (Building Envelope)

- Section 7.4.2 generally has more stringent requirements for building envelope
- Replaces Table 5.5-1 thru 8 on building envelope in 90.1, for example:

May be Revised in ISC

Table A-3 (supersedes Table 5.5-3 in ASHRAE/IESNA Standard 90.1)
Building Envelope Requirements For Climate Zone 3 (A,B,C) (I-P)

	Nonresidential		Residential		Semiheated	
	Assembly	Insulation	Assembly	Insulation	Assembly	Insulation
ue Elements	Max.	Min. R-Value	Max.	Min. R-Value	Max.	Min.R-Value
Roofs						
Insulation Entirely above Deck	U-0.039	R-25.0 ci	U-0.039	R-25.0 ci	U-0.119	R-7.6 ci
Metal Building	U-0.041	R-19.0 + R-10.0 filled cavity w/tb[d]	U-0.041	R-19.0 + R-10.0 filled cavity w/tb[d]	U-0.065	R-19.0
Attic and Other	U-0.021	R-49.0	U-0.021	R-49.0	U-0.034	R-30.0
Walls, Above-grade						
Mass	U-0.104	R-9.5 ci	U-0.090	R-11.4 ci	U-0.151[a]	R-5.7 ci[a]
Metal Building	U-0.072	R-13.0 + R-5.0 ci	U-0.053	R-13.0 + R-10.0 ci	U-0.084	R-19.0
Steel Framed	U-0.077	R-13.0 + R-5.0 ci	U-0.055	R-13.0 + R-10.0 ci	U-0.084	R-13.0 + R-3.8 ci
Wood Framed and Other	U-0.064	R-13.0 + R-3.8 ci	U-0.064	R-13.0 + R-3.8 ci	U-0.064	R-13.0 + R-3.8 ci

Highlights for Energy (Chapter 7)

(§7.4.2 a)

Prescriptive Option (Building Envelope)

- Example comparisons:

Example:
Climate zone 3 **Std 90.1 Std 189.1**
Insulation above deck R-15 ➔ R-25

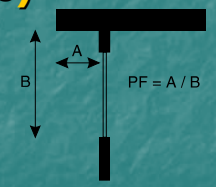
- More stringent SHGC

Example for 10-40% window area:
Climate zone 5
Std. 90.1: 0.39 (0.49 north)
Std. 189.1: 0.35 all orientations

Highlights for Energy (Chapter 7)

Prescriptive Option (Building Envelope)

- Vertical fenestration <40% wall area **(§7.4.2 d)**
- Overhang: PF > 0.5 **(§7.4.2 e)**

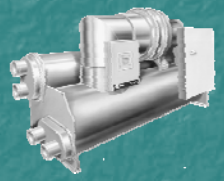


- Permanent projections: west, east & south
- Climate zones 1-5

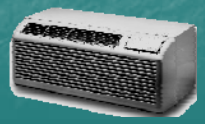
Highlights for Energy (Chapter 7)

Prescriptive Option (Mechanical)

- Higher equipment efficiencies



- More pipe/duct insulation
- Fan power allowance 10% less
- Unoccupied hotel/motel rooms to have auto-shutoff



Highlights for Energy (Chapter 7)

Prescriptive Option (Lighting)

- Interior lighting power to be 10% less than ASHRAE Standard 90.1
- Occupancy sensor controls
- Auto-controls for lighting in daylight zones

§7.4.3 HVAC

ASHRAE STANDARD
90.1 (current version)
Energy Standard for Buildings Except Low-Rise Residential Buildings

Adapt, with modifications

General Concept:

Base on Standard 90.1, but modify to gain improved energy performance over code minimum standards

§7.4.3 HVAC

- Brief mention of modifications to Std. 90.1
  - §7.4.3 (a) Expanded air economizer requirement
  - §7.4.3 (b) Minimum equipment efficiency ↑
  - §7.4.3 (c) Motorized dampers exception
  - §7.4.3 (d) Lowers DCV occupancy threshold
  - §7.4.3 (e) Duct sealing level A everywhere
  - §7.4.3 (f) Expanded economizer requirement
  - §7.4.3 (g) Zone reheat
  - §7.4.3 (h) Fan power limitation 10% lower
  - §7.4.3 (i) Added part-load fan power limits

§7.4.3 HVAC

- Brief mention of modifications to Std. 90.1 (Continued)
  - §7.4.3 (j) Lowered pump power threshold
  - §7.4.3 (k) Expand energy recovery req't
  - §7.4.3 (l) Kitchen hoods add variable speed
  - §7.4.3 (m and n) Minimum duct and pipe insulation increased (Tables C-16, 17 and 18)
  - §7.4.3 (o) Added pipe sizing/flow limitation
  - §7.4.3 (p) Unoccupied hotel/motel guest rooms

Highlights for Energy (Chapter 7)

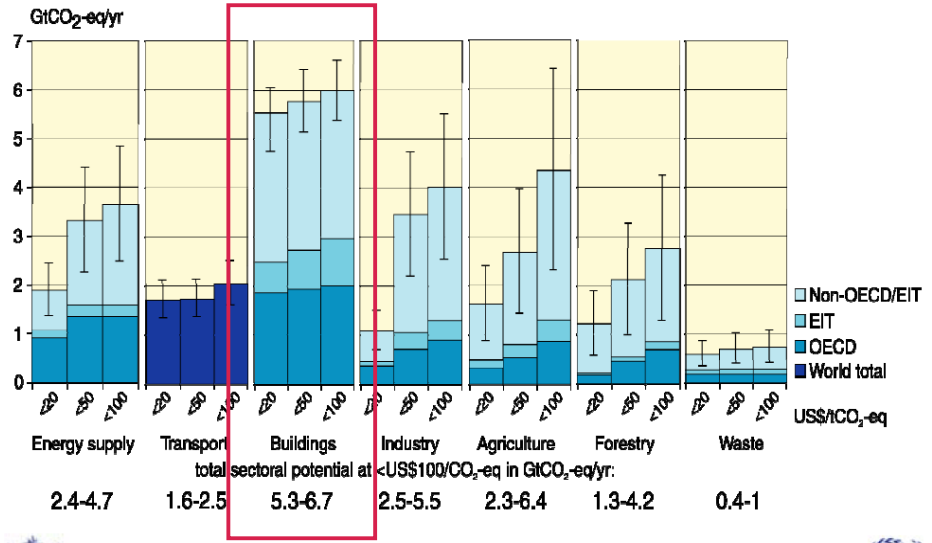
Performance Based Option:

- Demonstrated equivalent performance in **both** ***energy*** and ***CO_2 equivalent*** compared to if using the Prescriptive path

Proposed ≤ Mandatory + Prescriptive Path

Using Appendix D "Performance Option for Energy Efficiency"

Economic mitigation potential by sector in 2030



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

WMO UNEP

Highlights for Energy (Chapter 7)

Performance Based Option:

- ***CO_2 equivalent*** compared to building designed to the Prescriptive path

Table 7.5.3: CO_2e Emission Factors

Building Project Energy Source	CO_2e kg/kWh (lb/kWh)
Grid delivered electricity and other fuels not specified in this table	0.758 (1.670)
LPG or propane	0.274 (0.602)
Fuel oil (residual)	0.312 (0.686)
Fuel oil (distillate)	0.279 (0.614)
Coal (except lignite)	0.373 (0.822)
Coal (lignite)	0.583 (1.287)
Gasoline	0.309 (0.681)
Natural gas	0.232 (0.510)

National (U.S.) based numbers

Indoor Environmental Quality (§ 8)

- Mandatory Key Items to ASHRAE members:
  - **Outdoor airflow**
  - **Tobacco smoke control**
  - **Outdoor air monitoring**

ASHRAE STANDARD
Refers to and modifies
Ventilation
for Acceptable
Indoor Air Quality

Indoor Environmental Quality

§8.3.1 Minimum IAQ

- **1.3 times Standard 62.1-2004 outdoor airflow for offices and classrooms** *(climate zone and other exceptions)*
  - **Climate zones 1A and 2A**
  - **Offices zones 6,7,8 without heat recovery**
  - **Non-attainment air quality areas**
  - **Design according to IAQ procedure**
- **Non-attainment $PM_{2.5}$**
  ➔ MERV 13 filters

Example, and discussion on additional outdoor airflow requirement

Indoor Environmental Quality

- **§8.3.2**
  Environmental Tobacco Smoke Control
  - ***No smoking inside, with signage***
  - ***No smoking within 25 feet of entrance, outdoor air intakes or operable windows***

Indoor Environmental Quality

Indoor Environmental Quality:

Mandatory:

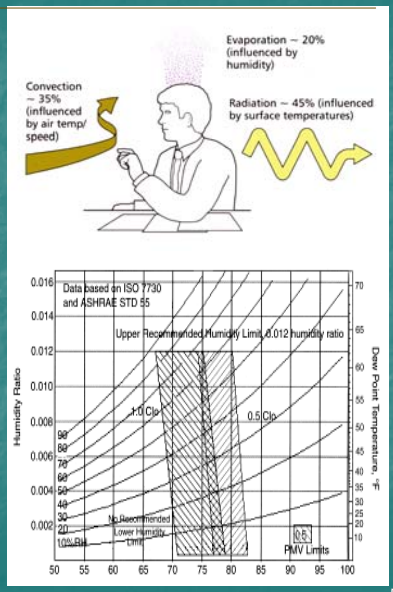
- **§8.3.3 Outdoor Air Monitoring**
  - CO_2 monitoring for systems serving densely occupied spaces (lower threshold for ***densely occupied*** than Std. 90.1-2007)
  - Non-densely occupied spaces monitor outdoor airflow to ±15% of ***design minimum outdoor airflow rate***

Being Revised in ISC

Indoor Environmental Quality

Other Mandatory:

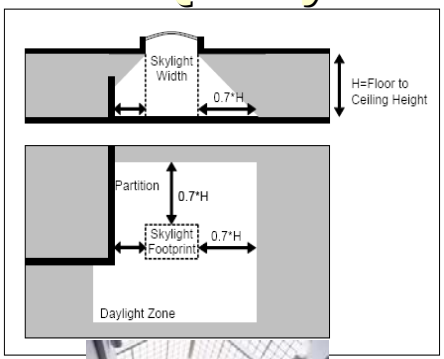
- Thermal Comfort
  - Comply with ASHRAE Std 55
- Mat systems at building entrances
- Acoustical design for envelope (sound transmission rating criteria)



Indoor Environmental Quality

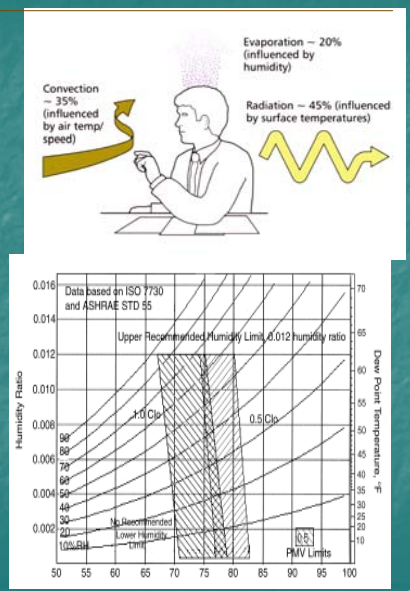
Other Mandatory:

- **Minimum MERV 8 filtration upstream of cooling coils (revises 62.1)**
- Daylighting by toplighting for large open spaces



Indoor Environmental Quality (Ch 8)

- Mandatory:
- Thermal Comfort
  - Comply with ASHRAE Std 55
- Mat systems at building entrances



Indoor Environmental Quality

Prescriptive Option (§8.4):

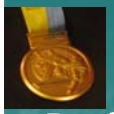
- Side daylighting
  - Offices and classrooms
  - Minimum effective aperture of windows
  - Minimum visible reflectance of interior surfaces
  - Exceptions for 'dark rooms', facades closely adjacent to other buildings

Indoor Environmental Quality

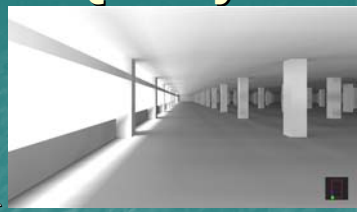
Prescriptive Option (Cont'd):

- Office space shading, with projections or other techniques
- Low emitting materials
  - Adhesives and sealants
  - Paints and coatings
  - Floor covering materials
  - Composite wood and agrifiber products

Indoor Environmental Quality



Performance Option (§8.5):



- Daylighting simulation
  - All regularly occupied spaces
  - Minimum illuminance target: 300 lux (30 fc) on work surfaces, 4.5 m (15 ft) from facade, noon equinox
  - Direct sunlight on workplane < 20% of occupied hours on equinox day
- Modeling to show compliance with California CA/DHS/EHLB/R-7174 (low emitting materials)

May be Revised in ISC

Building's Impact on Atmosphere, Materials and Resources (§ 9)

Mandatory Items Key to ASHRAE:

- **CFC, other refrigerant restrictions**
  - ***No CFCs***
  - ***Global warming and ozone depletion potential balance***

$$LCGWP + LCODP \times 10^5 \leq 775\ (100)$$

  - ***LCGWP = Life cycle global warming***
  - ***LCODP = Life cycle ozone depletion***

Units: kg CFC11 / kW-yr
lb CFC11 / ton-yr

Building's Impact on Atmosphere, Materials and Resources (§ 9)

Refrigerant restrictions (Continued):

where:

$LCGWP = [GWP_r \times (L_r \times Life + M_r) \times R_c]/Life$

$LCODP = [ODP_r \times (L_r \times Life + M_r) \times R_c]/Life$

- ***GWP_r* = global warming potential**
  0 to 12,000 kg CO_2 / kg refrigerant
- ***ODP_r* = ozone depletion potential**
  0 to 0.2 kg CO_2 / kg refrigerant
  - ***L_r* = Leak rate**
  - ***M_r* = End of life refrigerant loss**
  - ***R_c* = Charge**

Building's Impact on Atmosphere, Materials and Resources (§ 9)

Refrigerant restrictions (Continued):

For multiple types of equipment, a weighted average of all HVAC&R equipment shall be applied using the following formula:

$$[\sum (LCGWP + LCODP \times 10^5) \times Q_{unit}] / Q_{total} \leq 775\ (100)$$

where:

Q_{unit} = Cooling capacity of an individual HVAC or refrigeration unit, kW (tons)

Q_{total} = Total cooling capacity of all HVAC or refrigeration

- ***Exception:***
  Small HVAC units, coolers with < 0.5 lb refrigerant charge

Building's Impact on Atmosphere, Materials and Resources (§ 9)

- **Life Cycle Assessment (Performance)**
  - Must include operating energy consumption
  - LCA to include all of these impact categories: land use, resource use, climate change, ozone layer depletion, human health effects, ecotoxicity, smog, acidification, eutrophication
  - show 5% gain in two categories for the building

10 - Construction and Operation Plans

Mandatory:

- Full commissioning for projects > 5,000 ft^2
  - HVAC, building envelope, lighting, irrigation, plumbing, domestic water, renewable energy
- Addition of monitoring equipment for measurement and verification, M&V plans
  - water, energy and IAQ
  - M&V plans in place
  - certification of lamp and ballast recycling

10 - Construction and Operation Plans

§10.3.3.3 Energy Efficiency

Two compliance paths

- Comparison to CBECS benchmark 12-18 months after occupancy
- Energy simulation

- Done every 3 years

Table 10.3.3.3 Threshold for Energy M&V Evaluation

Building Usage Category	M&V Threshold, m^2 (ft^2)
Food Service (Restaurant)/ Food Sales (Grocery Store) Health Care Inpatient Health	>2,000 (20,000)
Lodging Office Public Order & Safety Outpatient Health Public Assembly Education	> 4,000 (40,000)
Retail Religious Worship	> 5,000 (50,000)
Warehouse Non-Refrigerated Storage Other*	> 8,000 (80,000) > 2,000 (20,000)

10 - Construction and Operation Plans

§10.3.3.4 Indoor Environmental Quality

- If CO2 monitoring, determine maximum allowable *action level* per Standard 62.1 for that zone type
- For outdoor air flow, monitor and react if flow < *minimum outdoor airflow rate (±15%)*
- IAQ Plan

Construction and Operation

Mandatory:

- Construction IAQ management plan

For IAQ testing

TABLE 10.3.8 Maximum Concentration of Air Pollutants

Contaminant	Maximum Concentration
Formaldehyde	50 parts per billion
Particulates (PM10)	50 mcg/m^3 (50 ppb)
Total Volatile Organic Compounds (TVOC)	500 mcg/m^3 (500 ppb)
4-Phenylcyclohexene (4-PCH)[a]	6.5 mcg/m^3 (6.5 ppb)
Carbon Monoxide (CO)	9 ppm and no greater than 2 ppm above outdoor levels

[a] This test is only required if carpets and fabrics with styrene butadiene rubber (SBR) latex backing material are installed as part of the base building systems.

Compare Standard 189.1 to LEED

LEED-NC

Green Building Rating System
For New Construction & Major Renovations

Version 2.2

For Public Use and Display

October 2005

BSR/ASHRAE/USGBC/IESNA Standard 189.1P

Public Review Draft

ASHRAE® Standard

Proposed Standard 189.1P, *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings*

Second Public Review (February 2008) (Complete Draft for Full Review)

- Voluntary vs. mandatory

- Std. 189.1:
  - Improvement in all topical areas
  - Pushes the envelope

FURTHER INFORMATION

- Information on ASHRAE standards:
  www.ashrae.org *then follow "Standards", includes listserv for Standard 189.1*
- Information on USGBC programs:
  www.usgbc.org
- Information on IESNA programs:
  www.iesna.org

Thank you!

- Comments, questions, concerns, advice ...

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